Received: 13 November 2017 | Revised: 13 February 2018 | Accepted: 14 February 2018
DOI: 10.1002/wat2.1285

ADVANCED REVIEW

Environmental water efficiency: Maximizing benefits and minimizing costs of environmental water use and management

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Funding information
ARC DECRA, Grant/Award numbers: DE160100213, DE150100328, DE180100550

Environmental water management is a relatively new discipline, with concepts, management practice and institutional mechanisms that are still emerging. The efficient and effective use of environmental water to maximize environmental benefits, or *environmental water use efficiency*, is one such emerging concept. Currently, much of the focus is on *allocative efficiency,* where the objective is to achieve a better balance between consumptive and environmental water uses in a cost-effective way. However, this may not provide the most efficient and effective way to manage environmental water in the long term, where managers are seeking *productive (or operational) efficiency.* Here, the objective is to maximize environmental outcomes relative to the cost of managing the available resource. This paper explores the concept of water use efficiency in the context of environmental water.

This article is categorized under:
Engineering Water > Planning Water
Human Water > Value of Water

KEYWORDS
efficiency, environmental flow, environmental water

1 | INTRODUCTION

In 2015, water crises were listed as the top global risk in terms of future impacts (World Economic Forum, 2015). As our water becomes scarce, and demand for water increases, there is pressure to improve water use efficiency and institutions that increase productive output (Saleth, Dinar, & Frisbie, 2011). To counter increasing water scarcity, many governments are adopting water use efficiency measures to improve consumptive outputs (e.g., agricultural cropping) with less water, and by reallocating water from lower value to higher value uses (Perry, Steduto, & Karajeh, 2017). In countries where water markets exist, the high cost of acquiring water during scarcity is also driving water use efficiency. But as consumptive use of scarce water resources has increased, so too has our appreciation of the need to provide environmental water to maintain the sustainable resource base of the rivers, wetlands, and other water sources on which all water users depend (Harwood et al., 2017; Horne et al., 2017). Sustainable freshwater resource management is essential if the UN (United Nations) Sustainable Development Goal (SDG) 6 (Clean Water and Sanitation) is to be achieved. Hence, as we approach the final decade of investment in the SDGs, it is increasingly important to obtain adequate quantities of environmental water, and then to use that water in a way that most efficiently and effectively achieves ecological targets.

The concept of efficiency is now widely discussed in the context of private agricultural water users (Adamson & Loch, 2014; Gómez & Pérez-Blanco, 2014; Perry, 2011; Wheeler, Zuo, & Loch, 2015) who are in the more mature stages of water use patterns and knowledge. But environmental water managers at earlier stages of their water use knowledge and practice development arguably require a greater focus on identifying and advancing cost-effective arrangements that maximize sustainable ecosystem outcomes from available water. The purpose of this paper is to introduce and explore the concept of e*nvironmental water use efficiency.* There are a range of ways that environmental water can be allocated through policy (e.g., caps or legal rights). The way in which water is allocated has implications for the level of management flexibility and required ongoing decision-making (from very active to more passive organizational structures to manage environmental water). This in turn has implications for the potential benefits and the transaction costs of environmental water. It is these links between institutional arrangements and costs and benefits that are explored in this paper.

2 | WHAT IS ENVIRONMENTAL WATER, AND HOW IS IT ALLOCATED?

The terms *environmental water*, *environmental flows*, and *instream flow* are familiar to most water scientists and managers. However, they are typically defined differently in different jurisdictions. It is important to have clear definitions, and in particular to distinguish between the scientific views of what water is required by the environment (Dyson, Bergkamp, & Scanlon, 2003), and the water resources management view of what water is actually provided (Murray-Darling Basin Authority (MDBA), 2013). In this paper, we deliberately avoid the term "environmental flow" as it has strong but very different associations for different people, and instead rely on the terminology provided in Box 1.

BOX 1

TERMINOLOGY (ADAPTED FROM HORNE, O'DONNELL, & THARME, 2017)

Environmental water: All water legally available to the environment through the array of possible allocation and legislative mechanisms. Each year, the precise volume of environmental water allocated or remaining under these legal mechanisms may vary depending on total water availability, demands, and priorities.
Environmental flows assessment: Is the process used to determine the environmental water requirement for targeted ecological endpoints (Tharme, 2003).
Environmental water regime: Is the quantity, timing, and quality of water required to sustain freshwater and estuarine ecosystems, and the human livelihoods and well-being that depend on these ecosystems (Brisbane Declaration, 2007). The key aspect is that "regime" captures the time-varying nature of flow.
Environmental water management: Includes the process of determining, allocating, implementing, and managing environmental water, and operates on a spectrum between:

- Active: Where the environmental water manager must decide when, where and how to recover and/or use environmental water, typically to provide managed interventions at prioritized sites to meet periodic ecological objectives.
- Passive: Where water is provided under planning or regulatory instruments, and requires no ongoing decision-making by the environmental water manager.

Environmental allocation mechanisms: Are the policy mechanisms available to provide environmental water, including:

- Conditions on others, for example, rules-based water provided under planning or regulatory instruments.
- Legal rights for the environment, for example, water held in storage released on demand by the environmental water manager.

Environmental water encapsulates resources delivered via policies or allocation arrangements to provide *"the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems, and the human livelihoods and well-being that depend on these ecosystems"* (Brisbane Declaration, 2007). By its very nature, this process involves a complex mix of institutions, rules, and allocation mechanisms (Horne, O'Donnell, & Tharme, 2017; O'Donnell & Garrick, 2017). A key question for environmental water managers is: given the objective to achieve environmental benefits from allocated water, what are the most cost-effective institutional arrangements and management choices that will maximize those benefits over short- to long-term timeframes? While these choices will be heavily influenced by community values and preferences for water resources, political will and existing policy settings, the choice of institutional arrangement can be informed by concepts from law, economics, and hydrology.

In this paper, we focus on the policy arrangements and mechanisms used to allocate and manage water to the environment. While there are local nuances, the way in which environmental water is allocated can be categorized:

1. Legally—Does the mechanism allocate water to the environment by imposing a limit on the water rights of other users, or by creating new legal rights to water for the environment?
2. Hydrologically—What component(s) of a flow regime does the above mechanism provide? (O'Donnell, Horne, Tharme, & Garrick, 2018)

The combination of these two factors generates five broad mechanisms for allocating water to the environment (Table 1), each with different ecological and legal benefits, and different costs of set-up and operation.

Where the seasonal condition and water availability requires different environmental watering decisions, active management with its inherently more flexible approach, may be desirable (see Box 1 for definitions). When the available options for environmental management are relatively limited, they can be identified in advance and codified as rules for a passive management approach. However, both active and passive management options are vulnerable to changing behaviors of other water users, which can be hard to predict. Passive management, in particular, is especially sensitive, because it requires the rules that limit other water users' behavior to be enforced in predictable ways, which may not be the case during situations where water supply rapidly alters between the extremes of drought and flood under uncertainty.

Different combinations of these mechanisms, and their associated institutional arrangements, can be used to generate the maximum benefit from the available water in different contexts. The concept of using environmental water efficiently is still novel. Where it has been applied, the emphasis has been on the use of infrastructure to deliver environmental water where it

TABLE 1 Mechanisms for allocating water to the environment

Allocation mechanism	Description	Implementation options	Institutional requirements
Conditions on other water users			
Cap on consumptive water use	Limit on the total volume of licenses issued and/or the extraction/abstraction of water against these licenses	• A limit on gross or net extractions and/or volumes held in storage • Limit can be implemented as a percentage of total available resource or as a volumetric limit • More complex caps can be applied but will be more difficult to enforce	• Information on appropriate cap level • Clear rules and specified limits on further extraction • Monitoring, reporting, and compliance mechanisms[a]
License conditions for water abstractors	Conditions listed on the license of individual water users that restricts the volume and/or timing of extractions	• Minimum instream flow required before extraction • Variable instream flow regime protected before extraction • Seasonal license (e.g., wet season pumping only)	• Legislative power to set and enforce conditions • Monitoring and compliance mechanisms[a] • Penalties for abuse[a]
Conditions on storage operators or water resource managers	Conditions on a storage operator prescribing releases from storage for downstream ecological needs	• Passing a fixed daily release from storage • Passing a percentage of storage inflow • Passing a prescribed environmental flow regime	• Legislative power to set and enforce conditions • Monitoring and compliance mechanisms[a] • Penalties for abuse[a]
Legal rights for the environment			
Ecological or environmental reserve	Legally establishes environmental water as a prior right to consumptive water use	• A minimum flow target to meet critical ecological needs • An adaptive regime that provides a share of available flow to the environment as a priority	• Agreed national principles • Long- and short-term water requirement data • Annual priority-setting capacity • Agreements/protocols for adaptive water delivery and application strategies • Monitoring and compliance mechanisms[a]
Environmental water rights	Individual water access rights held by an environmental water manager	• In a system where water is stored for use in a dam, environmental water can be released to create any component of flow regime • In a system where water rights are linked to a share of river flow, environmental water rights can protect existing flows	• Information on flow regime profiles[a] • Agreements/protocols for adaptive water delivery and application strategies • Monitoring and compliance mechanisms[a]

Adapted from Horne, O'Donnell, and Tharme (2017).

[a] Activities that form part of broader water resource management.

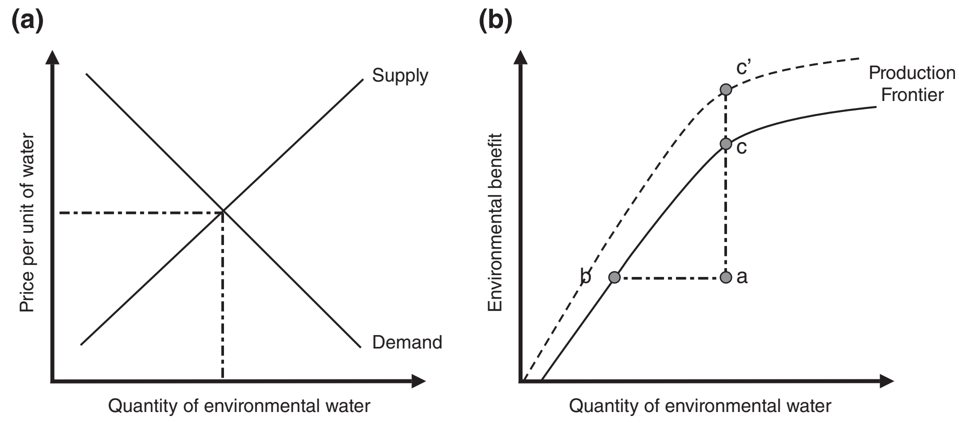

FIGURE 1 (a) Demand is the marginal social benefit of additional water allocated to the environment. Supply is the marginal social cost of reallocating water from other uses to the environment. Allocative efficiency involves an allocation to the environment at a quantity which equates demand and supply, which is where marginal benefit equals marginal cost. (b) Productive efficiency occurs as outcomes approach the production frontier, where the production frontier represents the maximum possible output given available resources and technological constraints. If current management is at position a, adopting different management strategies to achieve the same environmental benefit with less water could move onto the production frontier (point b) or achieving a greater environmental outcome with the same water (point c). A change in policy (including the allocation mechanism(s) and/or institutional arrangements), technology, or infrastructure may also shift the production frontier outward for further total environmental benefits (shown by the dotted curve)

is needed (so that smaller volumes of water can deliver greater ecological outcomes; MDBA, 2015; Thomas, 2017), but we argue that careful selection of allocation mechanisms can also increase benefits for the environment in cost-effective ways.

3 | ALLOCATIVE AND PRODUCTIVE EFFICIENCY

Concepts from the economics discipline can inform the choices of environmental water managers. From economics, we can employ two concepts relevant to the way we think about environmental water management: *allocative efficiency* and *productive efficiency*. Allocative efficiency concerns the allocation of scarce resources—in this case water—between competing water uses/users. Allocative efficiency occurs at an optimal distribution of water that takes into account society's preference for environmental benefits, given differences in costs (Figure 1a). Productive efficiency relates to achieving maximized profit or benefit from available resources (i.e., performing as close to the production frontier as possible; Figure 1b).

In the context of environmental water, allocative efficiency informs water use decisions at the margin on the basis of social objectives for example, how much water needs to be secured for the environment from water recovery programs in over-allocated systems? To achieve this, we can design a water regime that meets specific environmental needs today, and into the future (Acreman et al., 2014). Environmental water then targets a range of different environmental outcomes with different timing of water requirements. A change in the allocation mechanism or a change in delivery infrastructure may lead to a shift in the production frontier (dotted line), allowing better outcomes across all environmental water management objectives (a shift from c to c') (Figure 1b).

In implementing environmental water programs under conditions of water scarcity, the focus for policy makers has so far been mainly on allocative efficiency (i.e., the environment's share in contrast to agricultural or human consumption). With significant volumes of water recovered for the environment in the western United States (Wheeler, Garrick, Loch, & Bjornlund, 2013), Spain (Pérez-Blanco & Gutiérrez-Martín, 2017), and Australia (Loch et al., 2014), this focus is beginning to shift to include productive efficiency.

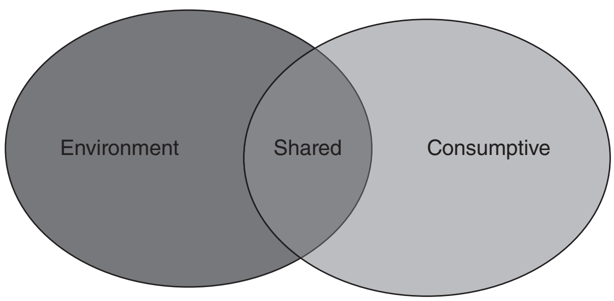

FIGURE 2 The total available water resource in a river basin is often thought of as being allocated to the environment or consumptive water users. However, there is also a portion of the water resource which provides shared benefits (i.e., consumptive water delivered to also achieve environmental outcomes, or environmental water that is harvested at a point further downstream for consumptive purposes)

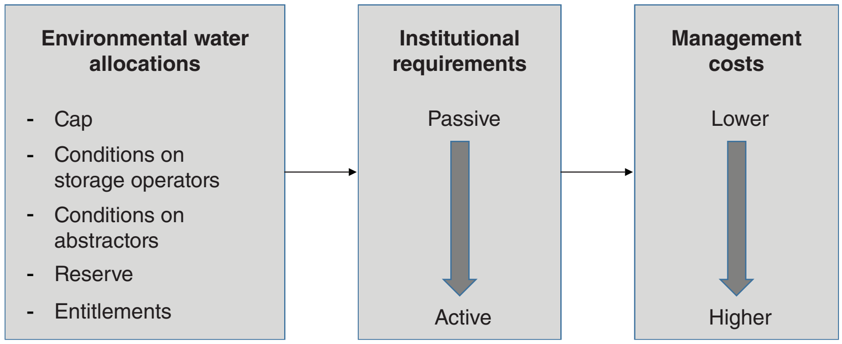

FIGURE 3 Institutional requirements and management costs for environmental allocation mechanisms

There are two key reasons why productive efficiency should also be an important objective for environmental managers. First, for most highly allocated river systems it will be possible to allocate the water required to meet all river management objectives, so there will be an underlying imperative to do the best with what water is available (Horne et al., 2017). Second, the river may be better able to support all water users if inefficiencies arising from the complex interaction between institutions, organizations, rules, and allocative mechanisms can be reduced. In other words, *the way environmental water is allocated can impact on the effectiveness of how it is used, which in turn affects how much water needs to be allocated to the environment.*

3.1 | Why does the environment need new thinking around productive efficiency?

Water efficiency in the context of agricultural water use or urban supply focuses on reducing wasted resources by maximizing what is *used* from what is *delivered.* In economic terms, this allows maximum production per unit of water available. Productive water efficiency easily gains political acceptance in private agriculture by generating wealth for individual irrigators, and the wider rural community, under perceptions of static (or predictable) water supply conditions. As water-use efficiency increases (i.e., each unit of water delivers greater outputs, which can lead to higher profits), the economic value of scarce water rights increases. Thus, the concept of regional economic development via efficiently using water resources becomes idealized. In reality, the concept of water efficiency is complex and often poorly appreciated in terms of impacts on resource use (Adamson & Loch, 2014), which can often result in minor evidence of empirical savings (Perry et al., 2017) and unintended total growth in resource utilization that may collapse under future supply shocks (Pahl-Wostl et al., 2013).

The focus on allocative efficiency and environmental water recovery has also framed the environment and consumptive water use as being separate and excludable water uses. This obscures the fundamental role environmental water plays in maintaining the resource for other water uses (Tickner et al., 2017).

When the environment has its own rights (environmental water rights), there is a tendency to treat it as though it is just another water user, and environmental water managers often refer to themselves in those terms. For example, interviews with Australian environmental water managers in 2013 about their roles and responsibilities elicited the following responses:

> "*We're a water user; we're another water user, we need to be regulated like everyone else*"
> "[the] *environment is now the largest customer* [for water]"
> "[the environmental water manager] *must communicate to the public what its objectives and outcomes are, and account for public money... Did we grow a population of fish? Did we not grow carp?*" (O'Donnell, 2017a)[1]

However, there are three key reasons why the concept of water efficiency must be considered differently when applied to the environment:

1. *Aimed at providing a public benefit*: While individual (private) benefits from greater efficiency may be easily identified, the environmental water manager is more than just another water user in a water system. Environmental water managers generate *public goods.* The benefits may include: greater environmental resilience reducing the need for future public expenditure; cultural and social gains from knowing or accessing improved environmental assets; and improved potable water supplies that benefit all water users and in some cases may reduce the cost of treating water. Critically, these gains may not be realized (i.e., the decision maker fails to associate the gains with the process, or fails to realize the possibilities) and/or may occur outside of the area from where the environmental water was initially sourced (and in some cases, is provided). While the concepts and theories of environmental water efficiency are based on those of irrigation efficiency, the drivers and incentives are distinctly different as it is a public good, without a profit maximizing objective.

Instead, the environmental manager is aiming to achieve as close to the agreed river management objectives as possible, often with a less than sufficient volume of water.

2. *The environment is not always a consumptive water user*: Environmental water managers must allocate their water rights between ecological benefits, which can be consumptive such as pumping water into a wetland, or nonconsumptive where water remains in stream. The environmental water is not necessarily being consumed, but rather often remains in the river, and therefore provides shared benefits for other purposes further downstream.
3. *Water can be used for shared benefits*: A number of allocation mechanisms allow for water that is used to meet an environmental requirement to then be used by consumptive water users downstream. Similarly, water delivered for consumptive purposes may provide environmental benefits, and can be used to deliver environmental outcomes in stream (Docker & Johnson, 2017; Lowe, Horne, Stewardson, & Earl, 2009; Thomas, 2017). Thus, if we consider the total available resource, there is a slice of the pie that is consumptive water use, a slice that is environmental water and a slice that is used for shared benefits (Figure 2). The use of water rights for the environment, whilst legally secure, continues to frame the environment as an alternative use of water. The way water is allocated to the environment will change the incentives to explore options for shared benefits.

To address these differences, the concept of efficiency for environmental water use must consider a multidimensional construction of efficiency that aims to maximize benefits (including ecological outcomes as well as less tangible benefits such as flexibility and legal security) from the available volume of water in a cost-effective way, where costs include the costs of water recovery and management.

4 | MANAGING ENVIRONMENTAL WATER EFFICIENTLY: WHAT DOES THIS MEAN?

As a discipline, environmental water is still relatively young, and there are still significant gaps in understanding the institutional settings for managing environmental water to maximize benefits in a cost-effective way (Pahl-Wostl et al., 2013). Environmental water managers have begun contemplating how to maximize the full range of complex benefits (i.e., social, cultural, economic, and ecological) that are often expected from available environmental water, once it has been allocated (i.e., via the allocation mechanisms described above). In other words, the drive to improve productive efficiency is gaining traction. But this is a complex space in which the variables (how much water, how it is allocated, and how it is managed) interact in iterative ways. The allocation mechanism selected will affect possible environmental outcomes by providing different arrangements across a spectrum of (a) legal protections that limit vulnerability to political interventions and/or uncertainties of future water supply reliability under climate change, and (b) flexibility to change management approaches in response to variable water demands and changing knowledge. Flexibility will be more important in systems where one or

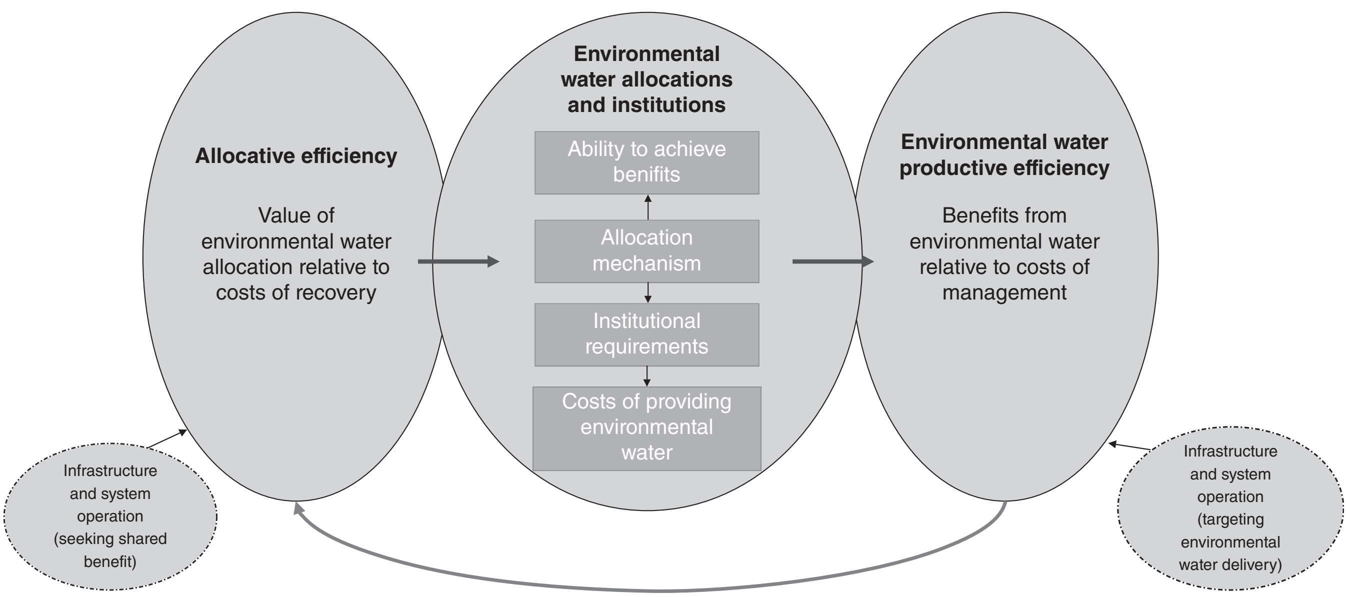

FIGURE 4 Allocative efficiency and productive efficiency link within the context of environmental water. Choices about how to allocate water to the environment necessarily involve selection between allocation mechanisms, which constrain the potential benefits and determine the required costs (i.e., they define the possible productive efficiency)

both of highly variable ecological requirements between years and highly variable available water to allocate between years is significant.

As the mix of institutional requirements shifts from passive to active arrangements, the management costs involved change. These include: fixed costs of holding, variable costs of using, and the water available under the allocation mechanism; costs of maintaining appropriate institutional arrangements (which is different for active and passive management); costs of establishing and maintaining organizations with the required capacity to manage the water (which will alter depending on the number of organizations involved, and any duplication of roles and responsibilities); the costs of coordination; and any costs of change when the existing arrangements fail or are deemed inappropriate (Figure 3, Box 2).

BOX 2

FLEXIBILITY VS COSTS

The institutional transaction cost (ITC) literature can be used to explore the link between flexibility and transaction costs. ITCs include: (a) *institutional transition costs* to describe, design, and implement new arrangements aimed at reorganization that correspond to an investment phase; and (b) *static transaction costs* to administer, monitor, and enforce those existing or new arrangements that correspond to a consolidation phase; where (c) our choices in both cases are constrained by prior institutional or technological *lock-in costs* (Marshall, 2013).

Garrick, Whitten, and Coggan (2013) discuss different ITC trajectories that lead to increasing lock-in or institutional flexibility over time. These trajectories may also relate to environmental water *adaptive efficiencies*, which signal the institutional capacity to solve evolving allocation and coordination dilemmas in dynamic contexts characterized by uncertainty and shocks (North, 1990). For example, passive (rules-based) management arrangements are less flexible (reflecting institutional lock-in), but may be a cost-effective outcome under circumstances of predictable environmental water demands, or where the array of water management decisions is reduced for other reasons, such as infrastructure access. At the other end of the spectrum, active management arrangements (contingent on water availability and seasonal conditions) reflect institutional flexibility that may be productively efficient in the face of uncertainty, facilitate opportunity to learn over time, and may even expand our environmental water options in future. Both approaches incur institutional transition costs of establishment, followed by static transaction costs for administration (although this is lower for passive management) and adaptive efficiency investments over time to improve institutional performance using feedback from policy reform and its implementation (North, 1994). The combination of these three cost categories enables managers to identify trajectories toward lock-in or institutional flexibility; but overall, the benefits from either arrangement must be positive for social welfare gains.

For each different water resource management system, the right balance of mechanisms to achieve productive efficiency will be defined by the decision space including: river/delivery constraints (such as flood levels, storage release valves etc.), variability in environmental water demand, the volume of environmental water to be managed, and the technology involved in its delivery. A study in the Yarra River, Victoria compared the benefits possible through active management of environmental water entitlements compared to a series of rules on storage operators and found the benefits of active management far exceeded the outcomes possible through rules (Horne et al., 2018). The Yarra River has highly variable environmental demands. A system with less interannual and intra-annual variability may respond better to a rules-based approach, no longer justifying the additional costs of active management. More generally, the transaction costs associated with acquisition and management of environmental water has also proven to be a significant challenge for the scaling up of environmental water recovery programs in the western United States (Garrick, 2015). Alternative legal arrangements for improving instream flows in the western United States may become more palatable if the costs of current arrangements were clearly attributable to the specific way in which water is allocated and managed.

The management process can also encompass opportunities to expand current limits to productive efficiency (frontier) through: improved coordination and cooperation; evaluation of, and changes to, existing management arrangements; and/or technology adoption which may enable an improvement in the efficiency of existing environmental water assets, with gains across the entire of social–ecological welfare measures. The selected allocation approach in a given system predicated on water use efficiency must be both feasible and resilient to future water supply shocks and/or demand adjustments.

While there are ongoing costs associated with both passive and active managements, it is possible to measure costs and benefits through time to determine the institutional performance trajectory for relevant environmental watering arrangements, and assess whether the additional benefits that accrue under active management (increased flexibility and legal security) are worth the added transaction costs. Finally, if those arrangements are deemed inappropriate, or begin to fail, then new investments in institutional transition costs will be required.

Efficient environmental watering depends on minimizing the costs of management, by aligning the objectives for environmental water with the appropriate allocation mechanism, and the required organizational capacity (O'Donnell et al., 2018). Whilst there has been some uptake of the concepts of productive efficiency by environmental water managers and policy makers (Horne, Stewardson, Freebairn, & McMahon, 2010; Pittock & Lankford, 2010), there has been little discussion of how this should be considered in the context of complex institutional interactions. To address that gap, we suggest that the mechanisms used to allocate water to the environment need to be carefully chosen, as each mechanism is linked to an array of regulatory and institutional settings (including governance and organizational capacity), with different costs and benefits for environmental water management (see Table 1). Figure 4 illustrates how the allocation mechanism and management arrangements provide the link between allocative efficiency and productive efficiency for environmental water management. This approach also recognizes that environmental water management decisions about system operation and infrastructure can influence both allocative efficiency and productive efficiency, along with other catchment and water resource management processes.

A key challenge not represented in Figure 4 is that the beneficiaries and funders of environmental water are not necessarily the same. The perceptions around which stakeholders or organizations are likely to bear specific costs (and reap the benefits) of different environmental water management mechanisms will often influence the choice of mechanisms more than any assessment of the overall cost. Interestingly, and perhaps counterintuitively, there is evidence that creating organizations to actively manage environmental water can change the social narrative around who is responsible for and who benefits from providing environmental water (O'Donnell, 2017a). We argue that a framework that more clearly articulates the costs and benefits (and who pays and gains) would influence these political decisions and social narratives.

5 | CONCLUSIONS

For 20 years, environmental water policy and management has focused on the question of: how much water does a river need? (Richter, Baumgartner, Wigington, & Braun, 1997) Environmental water programs emphasize the protection and recovery of environmental water to obtain the desired balance between consumptive and environmental water uses (allocative efficiency). In over-allocated systems, the methods used to recover water for the environment have been those considered most politically viable (and only sometimes the most cost-effective and benefit maximizing for the environment) (Horne, Freebairn, & O'Donnell, 2011; Wheeler, Garrick, Loch, & Bjornlund, 2013).

However, the ability to *use* environmental water efficiently and effectively will influence the determination of how much water is needed, and indeed the outcomes possible from that water. The most cost-effective and politically viable allocation mechanisms to recover water may not provide the most effective means to manage environmental water in the longer term. Acknowledging and understanding the implications of institutional arrangements for ongoing costs and benefits can help inform the ongoing political narrative and future policy directions. This paper forms a first step in developing a conceptual framework to consider environmental water efficiency.

It will take time to learn how best to use water resources to maximize environmental benefits. An initial step in this process will be better understanding the link between different allocation mechanisms and the implications in terms of management flexibility, ability to target specific aspects of the flow regime and institution requirements and costs. The best balance of allocation mechanisms will vary depending on the individual system.

This paper establishes the importance of considering *environmental water use efficiency*, and the role of water use efficiency for environmental water managers. While water markets and government programs will drive agricultural water use efficiency, these same incentives do not currently exist for environmental water management. Achievement of the most effective use of environmental water will require attention on the selection, design, and evaluation of the institutions that can maximize environmental benefits in a cost-effective manner.

The focus of this paper has been on environmental water use efficiency where water is allocated specifically to the environment. A history of over-allocation in many river systems has created the sense that environmental water use is in competition with human consumptive water uses. While allocating water to the environment provides legal security and environmental protection, the separation of different water uses creates inefficiencies in overall water resource management if it fails to provide incentives for shared benefits. This separation also encourages the belief that environmental outcomes belong to an individual environmental entity, rather than underpinning the resource that supports the cultural, social, and economic values of the wider community (O'Donnell, 2017b). While achieving environmental water use efficiency is important, the investment in the institutions to support this must be integrated into a broader water resource management approach. This is how the true marriage between productive efficiency and allocative efficiency will occur in the context of environmental water.

ACKNOWLEDGMENTS

A.H. (DE180100550), A.J.L. (DE150100328), and D.C.A. (DE160100213) were funded through ARC DECRA awards. We would also like to acknowledge the contribution of the editor and anonymous reviewers whose suggestions greatly improved the paper and figures.

CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

NOTE

[1]For more detail on the manner in which the interviews were conducted and the organizations included in the project, please refer to O'Donnell, (below), available at http://hdl.handle.net/11343/191749.

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How to cite this article: Horne AC, O'Donnell EL, Loch AJ, Adamson DC, Hart B, Freebairn J. Environmental water efficiency: Maximizing benefits and minimizing costs of environmental water use and management. *WIREs Water*. 2018;5:e1285. https://doi.org/10.1002/wat2.1285